

REMARKS

The Examiner is thanked for the Official Action of May 13, 2004. Currently, claims 1-13 are pending and were rejected by the Examiner in the office action. This request for reconsideration is intended to be fully responsive thereto. The Applicant submits a declaration under 37 C.F.R. § 1.132 to support his argument of patentability.

REJECTION UNDER 35 U.S.C. 102 (Hayashi et al.)

Examiner's Rejection

Claims 1-5 were rejected under 35 U.S.C. 102(b) as being anticipated by Hayashi et al. (JP8-287951). In the previous office action, the Examiner relied on the machine-translation of Hayashi et al. which allegedly teaches an electrode structure for an electrical component in which ions migrate between electrodes, e.g., a nonaqueous electrolyte secondary battery having an electrode active substance such as vanadium oxide coated with an ion-conducting polymer such as polyaniline. Further, Hayashi et al. is said to refer to the electrode active substance as "active material (2)" and the ion-conducting polymer as "active material (1)" and that the two active materials are mixed in solution and made to adhere to a current-collecting member, thereby obtaining "an electrode with a thickness of 45 micrometers".

In response to the Applicant's argument that the polyaniline in Hayashi et al. relates to electric conductivity and does not relate to ion-conductivity while so cited A.G. MacDiarmid et al., Mol. Cryst. Liq. Cryst. pp. 121 and 173, the Examiner suggested that the Applicant had failed to provide a copy of said article. Furthermore, the Examiner asserts that the polyaniline polymer in Hayashi et al. relates to ion-conductivity especially in consideration of applicant's definition of an ion-conducting polymer as one which can dissolve lithium salts. In Hayashi et al. a lithium salt sulfonic-acid anion complex is easily permeated into the polymer active material. Hayashi also teaches a criticality of the weight percentage of the active material, "[m]ore than 98wt%, there is a problem in respect of binding capacity or ion conductivity".

Support of Applicant's Previous Argument Regarding Hayashi et al.

As requested, the Applicant submits the copy of A.G. MacDiarmid et al., Mol. Cryst.Liq.Cryst. pages 121 and 173, which states polyaniline "has been synthesized in various forms both chemically and electrochemically in aqueous media". Clearly, conductivity of polyaniline as disclosed in Hayashi et al. relates to electronic conductivity. Furthermore, in Hayashi et al., (1) the conductive material such as polyaniline and the active material such as vanadium oxide are mixed with and dispersed in solvent; (2) this coating solution is applied/coated on a current collecting member; and (3) the coating solution is dried out to form an electrode. Here, both polyaniline and vanadium oxide are used as active materials and are not used for ion-migration.

Amendment

By these amendments, the Applicant limited the ion-conducting polymer as a polymer that is able to dissolve at least the lithium salts at a concentration of at least 0.1M (mol/l) and shows an electrical conductivity of 10^{-8} S (siemens)/cm at room temperature when dissolved with the lithium salts at a concentration of at least 0.1M. These amendments are clearly supported by the original description in the specification, and more particularly, e.g., between lines 10-13 on page 12 of the original specification. No new matter has been added.

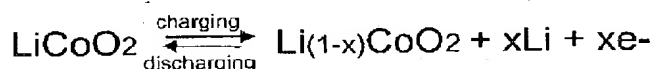
Declared Experiment

Advantages of employing this type of polymer coated on the surface of the powdered electrode active material is to shift the critical point at which thermal runaway occurs to a high temperature side. No conventional art, including Hayashi et al., teaches or suggests these limitations. In order to prove the advantages, the Applicant herewith provided a declared experiment. Please examine the following experiment results.

Definition of Overcharging

Although LiCoO_2 itself is a stable material, it becomes unstable when number of Li atoms in the molecular formula is equal to or less than 0.5, thereby categorized as in an overcharging state. It is known to explosively generate heat or burn when exposed to a high temperature atmosphere.

- (1) A general equation expressing the reaction on a positive electrode of the lithium ion battery is:



- (2) A following equation expresses the reaction of a fully charged lithium ion battery sold in a today's market:



Experiment A (ion-conducting polymer coating)

The electrode was prepared according to Example 4 (positive electrode) and Example 6 (negative electrode), and the sample battery was made according to (j) Charging/discharging tests on page 29. As the supporting electrolyte salt 1M LiBF_4 in a 1:1 volumetric mixture of ethylenecarbonate and diethylenecarbonate as the nonaqueous solvent was used. The sample battery was fully charged where the active material in the positive electrode was $\text{Li}_{0.5}\text{CoO}_2$.

Comparative Example B (polyvinylidene fluoride)

The electrode was prepared according to Comparative Example 1 (positive electrode) and Comparative Example 2 (negative electrode), and the sample battery was made according to (j) Charging/discharging tests on page 29. As the supporting electrolyte salt 1M LiBF_4 in a 1:1 volumetric mixture of ethylenecarbonate and diethylenecarbonate as the nonaqueous solvent was used. The sample battery was fully charged where the active material in the positive electrode was $\text{Li}_{0.5}\text{CoO}_2$.

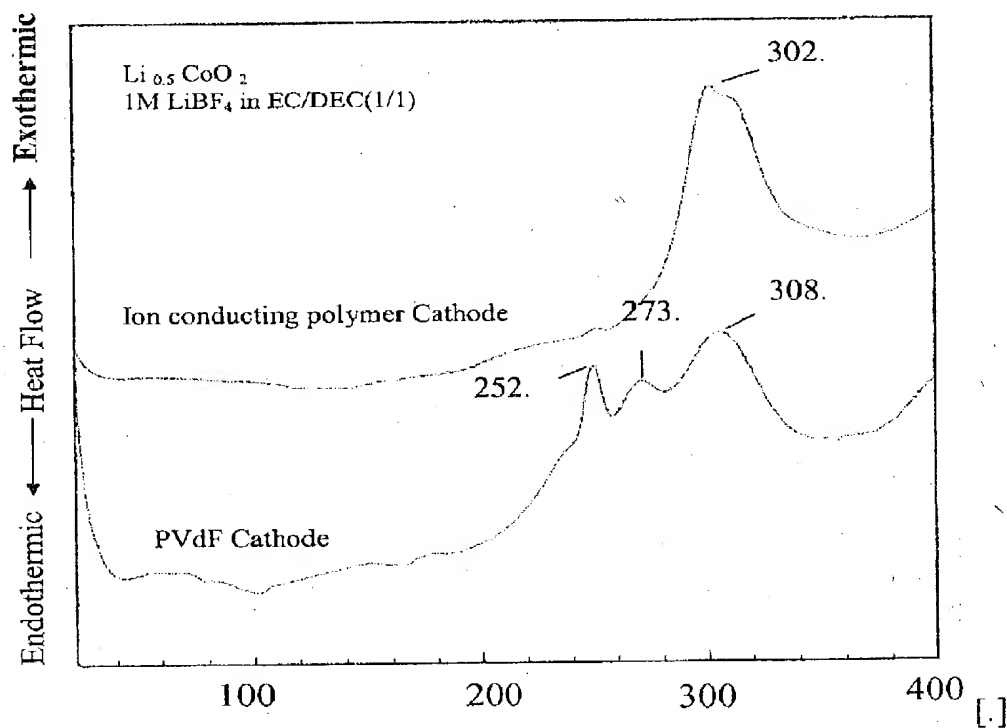
Measuring Method

The fully charged battery was decomposed under argon atmosphere to extract

the positive electrode active material ($\text{Li}_{0.5}\text{CoO}_2$). The extracted positive electrode active material was filled in a sealable aluminum test container to perform differential scanning calorimetry (DSC). Temperature was increased at $10^\circ/\text{min}$ to 400° . The following graph shows the heat flow measurement which shows some heat peaks after 250° . These are points at which thermal runaway occurs. This measurement was performed using a differential scanning calorimetry (Seiko Instruments Company Limited).

Results

The following graph shows the thermo runaway reaction of Comparative Example B using polyvinylidene fluoride (PVdF) at 252° , while the thermo runaway reaction of Experiment A using the ion-conducting polymer coating went up to 302° . Z.Zhang et al. explains about the experiment of measuring the thermo runaway point with respect to LiCoO_2 (normal state) and $\text{Li}_{0.014}\text{CoO}_2$ (thermo runaway point). Z.Zhang et al. J.Power Source, 70, 16(1998) (which is attached hereto). Z.Zhang et al. using PVdF shows the thermo runaway point approximately equal to Comparative Example B of this experiment. Accordingly, using the type of polymer in the present invention gives significant advantages over conventional arts by offering stability and safety.



REJECTION UNDER 35 U.S.C. 102 (Bai et al.)

Examiner's Rejection Regarding Claims 1-5 and 11-13

The Examiner rejected Claims 1-5 and 11-13 under 35 U.S.C. § 102(b) as being anticipated by Bai et al. (US5744258). However, Bai et al. does not teach or suggest the limitation regarding the ion-conducting polymer as amended in this action. Therefore, the rejection on this ground should be removed.

REJECTION UNDER 35 U.S.C. 102/103 REGARDING CLAIMS 6-10 (Hayashi et al.)

The Examiner rejected Claims 6-10 under 35 U.S.C. 102 or 103 as being anticipated by Hayashi et al. as applied to claims 1-5. However, Hayashi et al. does not

teach or suggest the limitation regarding the ion-conducting polymer as amended in this action. Therefore, the rejection on this ground should be removed.

CONCLUSION

No cited reference discloses or suggests the ion-conducting polymer dissolves at least the lithium salts at a concentration of at least 0.1M (mol/l) and shows an electrical conductivity of 10^{-8} S (siemens)/cm at room temperature when dissolved with the lithium salts at a concentration of at least 0.1M. The advantages of employing this polymer is supported by the current specification and the above experiment. No new matter has been added.

Accordingly, it is respectfully submitted that claims 1-13 define the invention over the prior arts and notice to this effect is respectfully solicited.

Should Examiner believe further discussion regarding the above claimed language would expedite prosecution he is invited to contact the undersigned at the number listed below.

Respectfully submitted,

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